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PICKERING NGS - VACUUM BUILDING POST-DOUSE INSPECTION OF FLOOR SLAB (UNDERSIDE)

Report No. 90-209-K

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ABSTRACT

A detailed inspection of the underside of the Vacuum Building floor slab was carried out after the douse test in June 1990. A visual assessment along with nondestructive tests was used to evaluate the condition of the floor slab. The concrete is in excellent condition, with only very minor extensions of a few previously identified cracks. Water leakage was noticed after the douse test through some of the original unrepaired cracks. The leakage rate was significantly less (ie, ≈97%) than that of the 1980 douse test. This reduction in leakage was attributed to the successful epoxy injection repair of cracks after the 1980 douse test. Additional sealing of the leaking cracks would further reduce the leakage through the floor slab.

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
2.0	OBSERVATIONS DURING DOUSING TEST	1
3.0	DISCUSSION	2
4.0	SUMMARY OF FINDINGS AND CONCLUSIONS	2
5.0	REMARKS	2
REFERENCES		4
FIGURES 1-7		5
TABLE 1		12
APPENDIX A		13
DISTRIBUTION		last page

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To Dr. C.F. Lee
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PICKERING NGS - VACUUM BUILDING
POST DOUSE INSPECTION OF
FLOOR SLAB (UNDERSIDE)

1.0 INTRODUCTION

During the May 1980 Pickering NGS Vacuum Building inspection, a douse test was carried out to verify the system's operational integrity. A pre-douse visual examination of the vacuum building had identified cracks in the main volume floor slab, and the douse test showed water leakage through some of these cracks into the basement below/1/. It was decided to repair and seal these cracks with epoxy injection/2 to 8 and 10 to 13/. The effectiveness of the repair was demonstrated by carrying out simulated laboratory tests/9/. Further, the slab was inspected periodically to ensure continued integrity of the crack repairs/14/.

As part of the in-service inspection program, a douse test was carried out in June 1990 to demonstrate the system's operational integrity. All the available water in the storage tank (approximately 9400 m^3) was emptied onto the floor slab in approximately 10 minutes. This report summarizes observations on the quality and overall assessment of the condition of the floor slab following the douse test. Visual examination, nondestructive tests and measurements of water leakage through the floor slab were carried out.

2.0 OBSERVATIONS DURING DOUSING TEST

The underside of the floor slab (El 251' 10½") was examined for signs of water leakage immediately after the completion of the dousing and periodically for the next 24 hours. Within the first two hours, when the hydrostatic head on the floor was at its maximum, a number of unrepaired cracks on the underside of the slab started leaking. Appendix A and Figures 1 to 7 identify the locations and extent of water leakage.

Table 1 shows the estimated leakage rate with time, following the douse test. For comparison, the leakage rate measured during the 1980 douse test is included. The leakage rate in 1980 was measured prior to the sealing of cracks by epoxy injection. The estimated leakage rate within the first two hour period in 1990 was 10.5 L/h compared to 365 L/h (~97% reduction) measured in 1980 at maximum hydrostatic head. As the water was pumped out of the Vacuum Building, the leakage rate decreased while the number of cracks which started leaking increased. This indicates that the maximum leakage rate would most likely have been somewhat greater if the hydrostatic head was maintained constant at its high water level.

It should be noted that the majority of water leakage at the two and four hours occurred at two locations (ie, Column G9 and G11 - Figures 2 to 5) and accounted for approximately 70% of the total leakage.

A total of 108 locations approximately 200 ft in length (Appendix A and Figure 1) were identified where cracks were damp or water droplets formed on the surface of the crack. It was noted that minor extension of a few existing cracks had occurred, similar to what was observed in the 1980 douse test.

3.0 DISCUSSION

It is important to note that the cracks which were treated from the underside of the slab by epoxy injection showed very little or no leakage at all (Figure 5), indicating that where repairs were previously carried out the leakage was virtually eliminated. These repairs account for the significant reduction in leakage when comparing the 1980 and 1990 douse tests. Also, the recent replacement of the sealant in the construction joints on the top of the slab prior to the douse test reduced the leakage through these joints (Figure 7). Ultrasonic pulse velocity measurements taken previously and compared to present measurements also confirm the effectiveness of the repairs/15, 16/.

4.0 SUMMARY OF FINDINGS AND CONCLUSIONS

(a) There is no evidence of any major extension of cracks in the Vacuum Building slab prior to and after the recent douse test.

(b) In its present condition, the main volume floor slab may still leak following a douse test. The leakage rate, however, would be significantly lower than what was measured during the 1980 douse test.

(c) The epoxy injection process proved to be successful in sealing cracks in the floor slab. The integrity of the repair is excellent, and the total leakage through the floor slab cracks has been reduced by ≈97% of the amount leaked in the 1980 douse test.

(d) Replacement of the joint sealant on the top of the floor slab has also contributed to the reduction in the leakage.

5.0 REMARKS

5.1 If required, the leakage through the floor slab currently observed can be further reduced by carrying out additional repairs as follows:

(a) The leakage around Columns G9 and G11 could be repaired by sealing with an epoxy mortar followed by epoxy injection of the cracks (ie, ≈40 ft).

(b) All other crack locations (ie, ≈160 ft) could be repaired by sealing the surface with an epoxy mortar only. No epoxy injection is required.

(c) The recommended materials for carrying out this work are:

(i) Capbond Ex grey (epoxy mortar) for sealing the surface of the cracks.
(ii) Capweld 524 for epoxy injection of the cracks.

5.2 External examination of the Vacuum Building floor slab, including ultrasonic pulse velocity measurements, and taking cores, should be carried out periodically, preferably at 5-year intervals as was established in 1985/14/.

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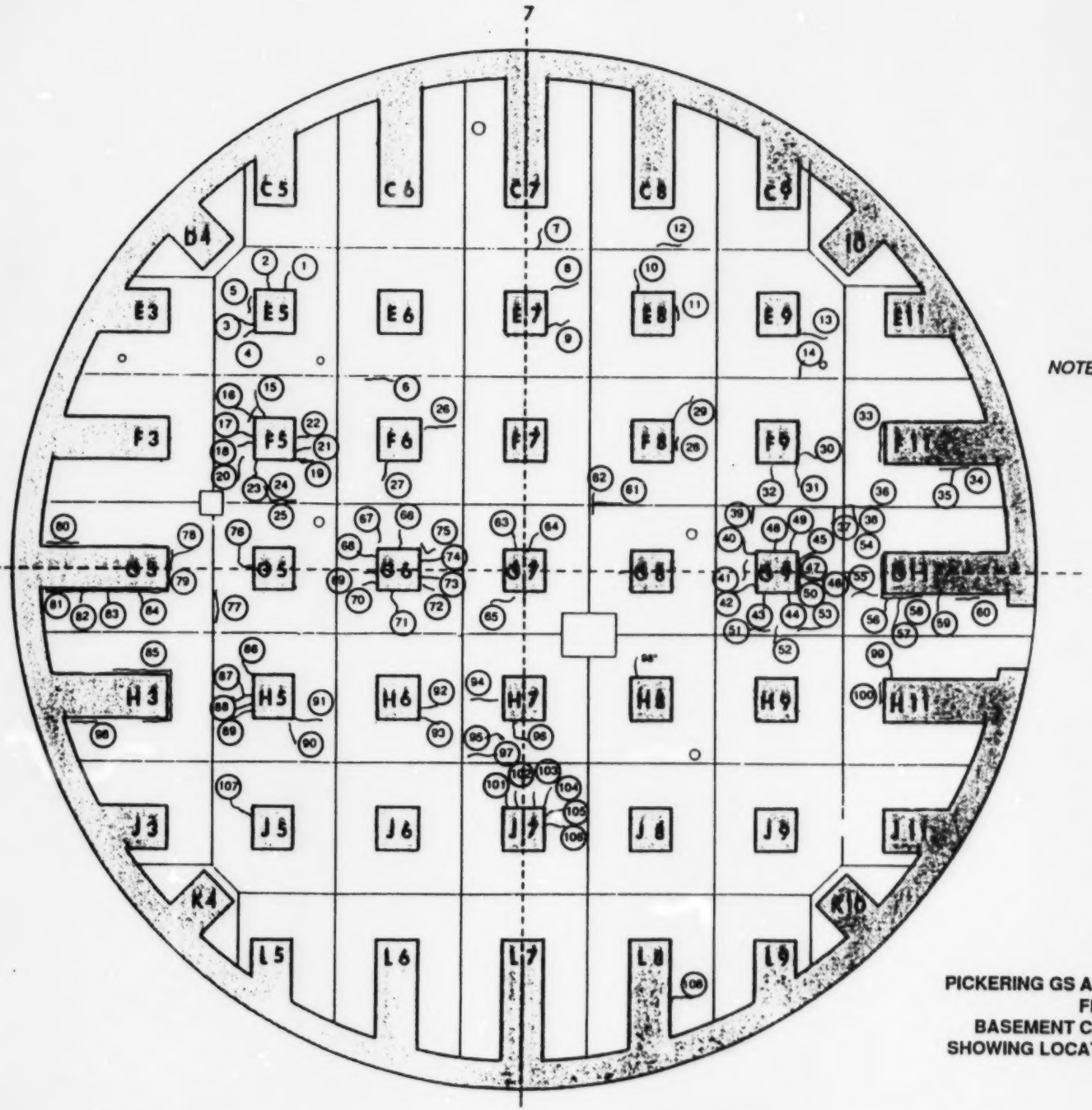


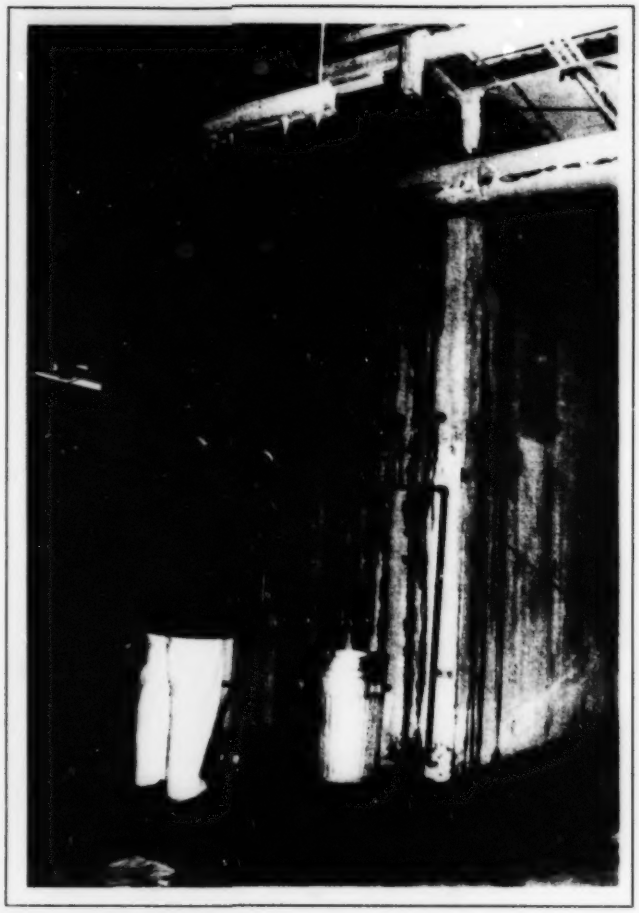
1990 Douse Test

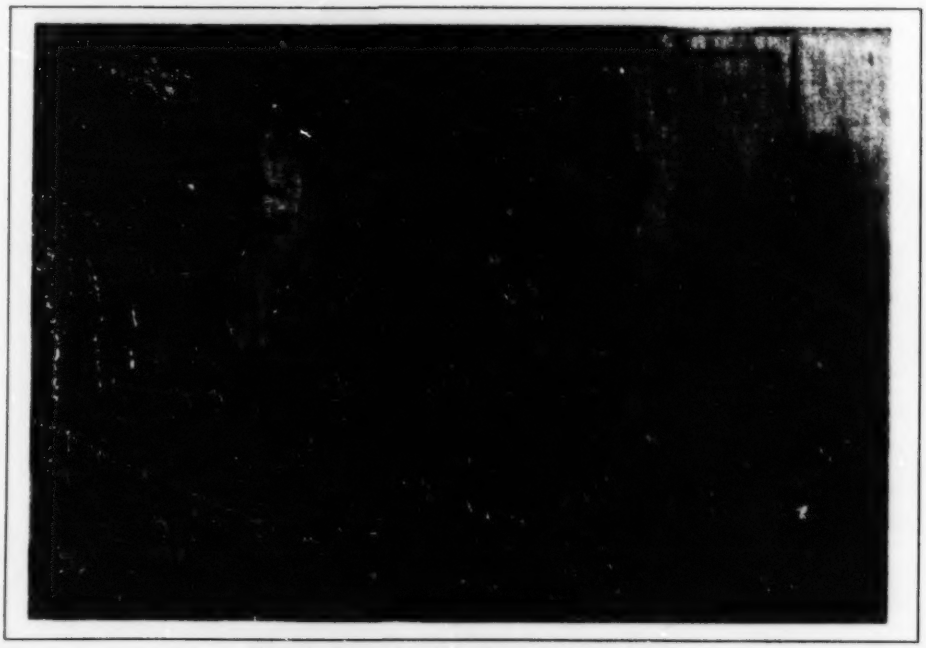
NOTES:

1. Refer to Appendix A for details of cracks as shown - (1)
2. Leaks seen within 24 hours of douse test
3. Water leakage occurred through existing cracks

FIGURE 1

PICKERING GS A AND B VACUUM BUILDING FLOOR SLAB BASEMENT CEILING ELEV. 251-10 1/2 SHOWING LOCATION OF WATER LEAKAGE





Steady flow of water down column face

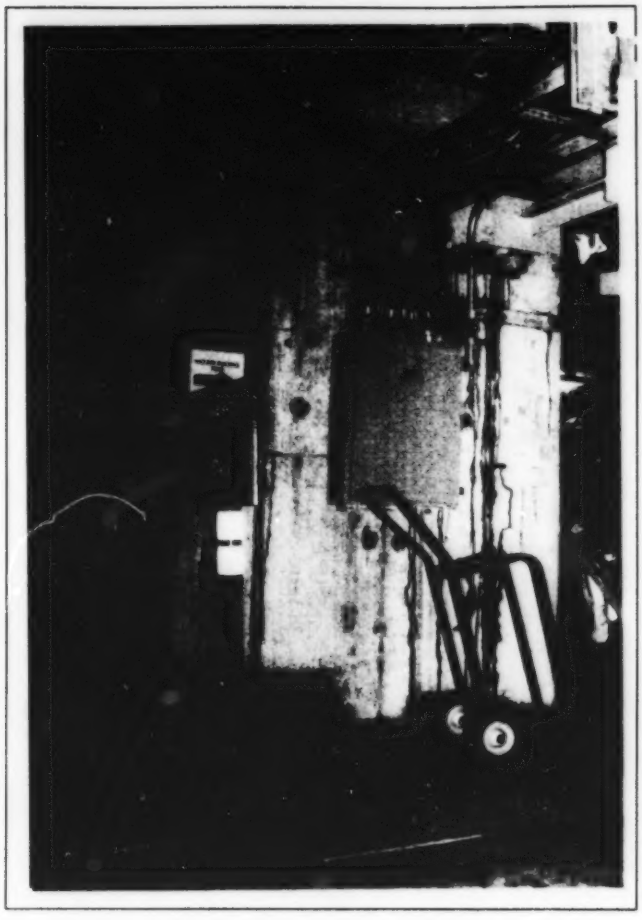
FIGURE 2

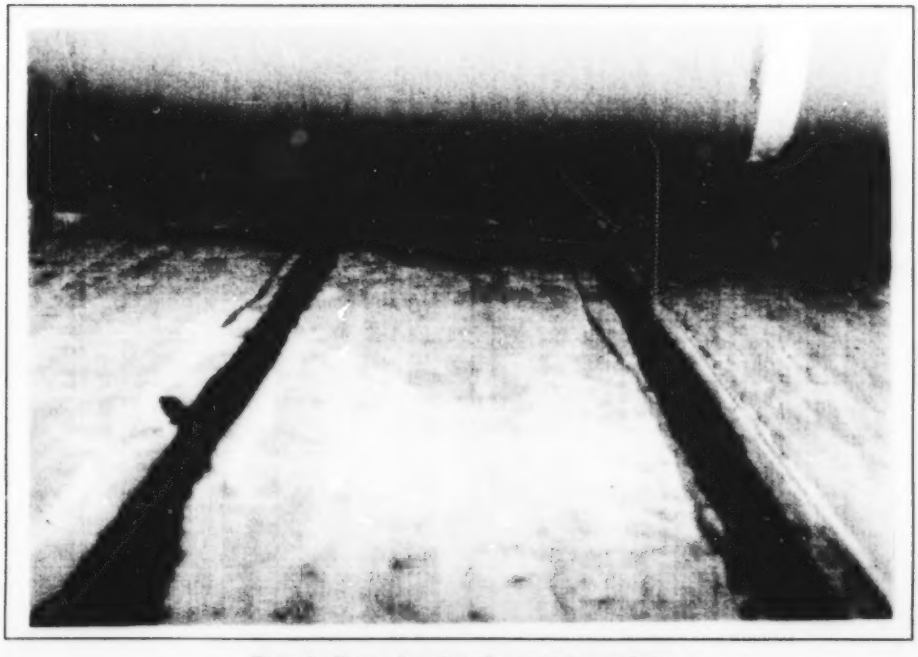
VIEW OF LEAKAGE AT COLUMN G11
WITHIN TWO HOURS OF 1990 DOUSE TEST

Rate of water leakage significantly reduced due to lower hydrostatic head, however, the number of locations and area of leakage increased.

FIGURE 3

VIEW OF LEAKAGE AT COLUMN G11 WITHIN TWENTY-FOUR HOURS OF 1990 DOUSE TEST

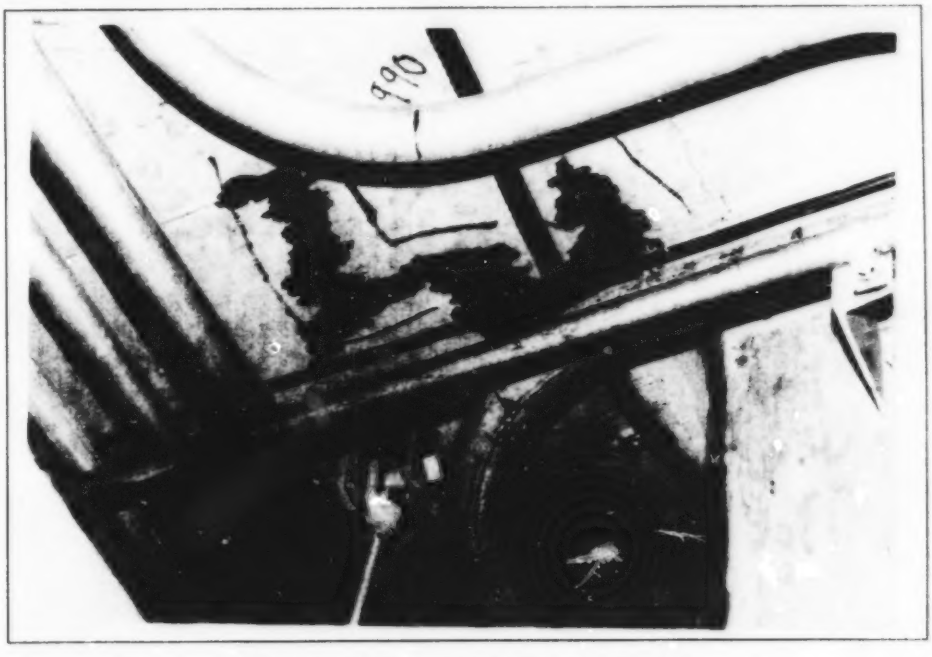




Steady flow of water down column face

FIGURE 4

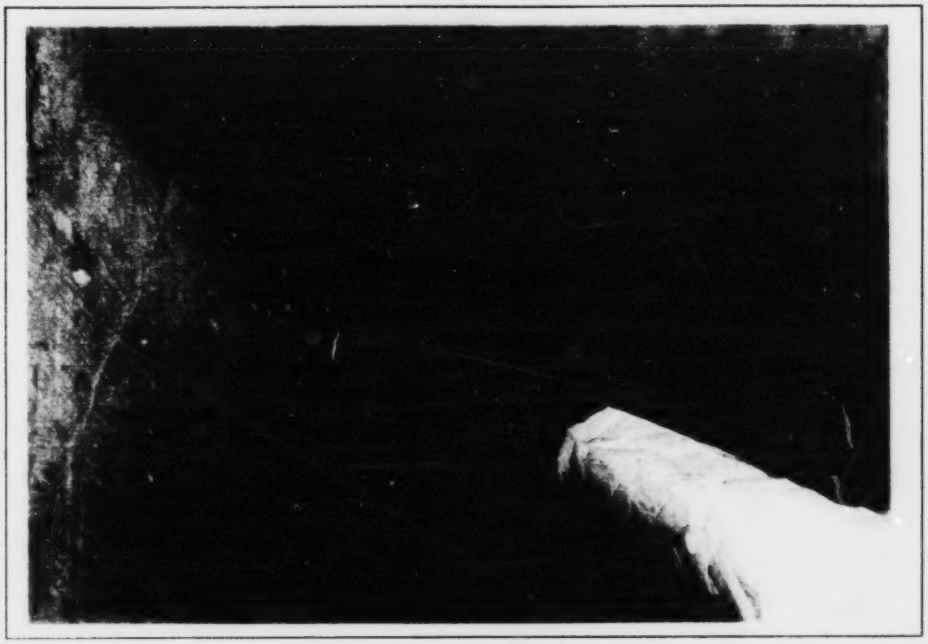
VIEW OF LEAKAGE AT COLUMN G9
WITHIN TWO HOURS OF 1990 DOUSE TEST



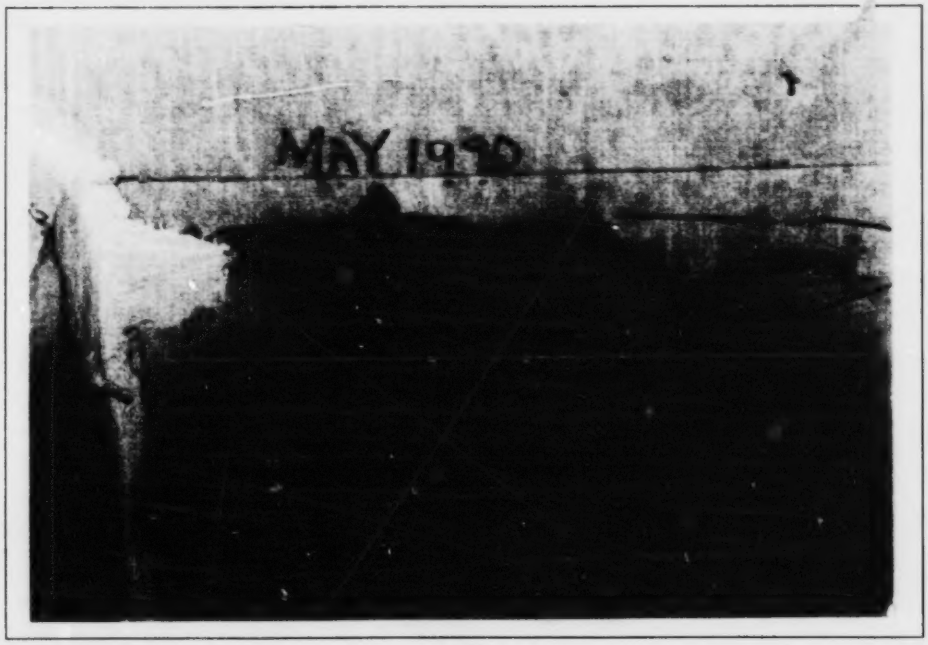
Water droplets formed on surface of crack

FIGURE 5

VIEW OF LEAKAGE THROUGH CRACKS IN FLOOR SLAB AT COLUMN G9 LOCATION (1990 DOUSE TEST)



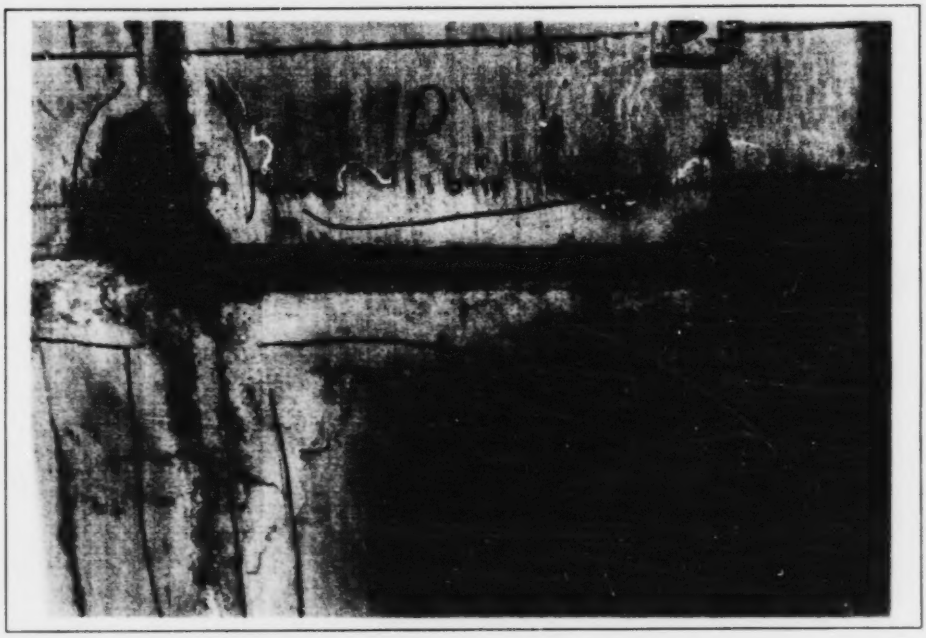
G3 East



J5 West

FIGURE 6

**VIEW OF LEAKAGE THROUGH
CRACKS NEAR COLUMN G3 EAST AND J5 WEST
(1990 DOUSE TEST)**



Joint located between Col F7-G7 and F8-G8

FIGURE 7

VIEW OF SURFACE DAMPNESS THROUGH CONSTRUCTION JOINT (1990 DOUSE TEST)

TABLE 1

Estimated Leakage Rate of Water Leaking Through Vacuum Building Floor Slab After the Douse Test

Time After Douse Test (h)	Leakage Rate (L/h)	
	1980 Before Repair	1990 /1/ After Repair
2	365	10.5
4	205	5
24	80	<2

/1/ Approximately 70% of total water leakage at 2 and 4 hours occurred at two locations (ie, Col G9 and G11)

APPENDIX A

Locations of Water Leakage on the Underside of the Floor Slab After the Douse Test

The following tables identify the location, length and extent of water leakage through the Vacuum Building floor slab after the 1990 douse test.

Table 1A
Locations of Water Leakage on the Underside of the Floor Slab
After the Douse Test

Location of Leak		Crack Number See Figure 1 of the text	Length (In)	Crack Repair Status	Remarks
Column Number	Bearing				Types of leakage noted at cracks
E5	North	1	3	x	Surface of crack damp
	North	2	4	x	Surface of crack damp
	West	3	12	x	Water droplets formed on surface of crack
	West	4	2	x	Surface of crack damp
	West	5	6	x	Surface of crack damp
E6-F6		6	12	x	Surface of crack damp
C7-E7		7	5	x	Surface of crack damp
E7	East	8	27	x	Water droplets on surface of crack
	East	9	8	x	Water droplets on surface of crack
E8	North	10	12	x	
	East	11*	4**	(†)	Water leaking around electrical cable tray at chamfer of column
E7-D8 (††)		12	4	x	Surface of crack damp
E9	East	13	8	x	Water droplets on surface of crack
E9	South	14	3	(†)	Extension of repaired crack, surface of crack damp
F5	North	15	24	x	Water droplets on surface of crack
	West	16	5	x	Water droplets on surface of crack
	West	17	27	x	Water droplets on surface of crack
	West	18	8	x	Water droplets on surface of crack
	East	19	32	x	Water droplets on surface of crack
	South	20	16	(†)	Extension of previously repaired crack
	East	21	4	x	Surface of crack damp

* Leakage noted around column perimeter
** Length of leakage path around column perimeter
x Unrepaired crack
(†) Repaired crack
(††) Construction joint

Table 1A (Cont'd)
Locations of Water Leakage on the Underside of the Floor Slab
After the Douse Test

Location of Leak		Crack Number See Figure 1 of the text	Length (In)	Crack Repair Status	Remarks Types of leakage noted at cracks
Column Number	Bearing				
	East	22	2	x	Surface of crack damp
		23	14	x	Water droplets on surface of crack
F5-G5		24	36	x	Water droplets on surface of crack
F5-G5 (††)		25	36	x	Water droplets on surface of crack
F6	East	26	24	x	Water droplets on surface of crack
F6	South	27	12	x	Water droplets on surface of crack
F8	East	28*	4**	(†)	Water leaking around electrical cable tray at chamfer of column
F8	East	29	18	x	Water droplets on surface of crack
F9	East	30	10	x	Surface of crack damp
F9	South	31	12	x	Surface of crack damp
F9	South	32	3	x	Surface of crack damp
F11	West	33*	84**	x	Surface of chamfer at column/floor slab location damp
F11	South	34*	9*	x	Surface of chamfer at column/floor slab location damp
F11	South	35	2	x	Surface of crack damp
F9-G9 (††)		36	12	x	Surface of joint damp
F9-G9		37	3	x	Surface of crack damp
F9-G9		38	3	x	Water droplets on surface of crack
F9-G9		39	36	x	Water droplets on surface of crack
G9	West	40	12	x	Water droplets formed on surface of crack
	West	41	8	x	Water droplets formed on surface of crack
	West	42	36	x	Water droplets formed on surface of crack
	South	43	2	x	Surface of crack damp
	South	44	4	x	Surface of crack damp
	East	45	4	x	Surface of crack damp

* Leakage noted around column perimeter
** Length of leakage path around column perimeter
x Unrepaired crack
(†) Repaired crack
(††) Construction joint

Table 1A (Cont'd)
Locations of Water Leakage on the Underside of the Floor Slab
After the Douse Test

Location of Leak		Crack Number See Figure 1 of the text	Length (In)	Crack Repair Status	Remarks Types of leakage noted at cracks
Column Number	Bearing				
	East	46			Water droplets formed on surface of crack
	East	47*	84**	(†)	Water dripping out injection ports along chamfer. It appears section of chamfer was never epoxy injected. Steady flow of water down column face.
	North	48	4	x	Surface of crack damp
	North	49	12	x	Surface of crack damp
		50*	84**	(†)	Water dripping out injection ports along chamfer. It appears that chamfer at this location was never epoxy injected.
G9-H9	South	51	36	x	Surface of crack damp
G9-H9		52	36	x	Surface of crack damp
G9-H9		53	12	x	Surface of crack damp
G11	West	54*	84**	x	Steady flow of water leaking down column face
	West	55	24	x	Water droplets formed on surface of crack
	South	56	3	x	Water droplets formed on surface of crack
	South	57	36	x	Water droplets formed on surface of crack
	South	58*	84**	x	Steady flow of water leaking down column face
	South	59	5	x	Surface of crack damp
	South	60*	48**	x	Surface of chamfer damp
F3-G8 (††)		61	24	x	Surface of crack damp
		62	4	x	Surface of crack damp
G7	North	63	6	x	Water droplets formed on surface of crack
G7	North	64	3	x	Water droplets formed on surface of crack
G7	South	65	8	x	Water droplets formed on surface of crack
G6	North	66	8	x	Water droplets formed on surface of crack
	North	67	10	x	Water droplets formed on surface of crack

* Leakage noted around column perimeter
** Length of leakage path around column perimeter
x Unrepaired crack
(†) Repaired crack
(††) Construction joint

Table 1A (Cont'd)
Locations of Water Leakage on the Underside of the Floor Slab
After the Douse Test

Location of Leak		Crack Number See Figure 1 of the text	Length (In)	Crack Repair Status	Remarks
Column Number	Bearing				Types of leakage noted at cracks
	West	68	12	x	Water droplets formed on surface of crack
	West	69	3	x	Water droplets formed on surface of crack
	West	70	3	x	Water droplets formed on surface of crack
	South	71	30	x	Water droplets formed on surface of crack
	East	72	4	x	Water droplets formed on surface of crack
	East	73	5	x	Water droplets formed on surface of crack
	East	74	6	x	Water droplets formed on surface of crack
	East	75	1	x	Water droplets formed on surface of crack
G5		76	32	x	Water droplets formed on surface of crack
G5-G3 (††)		77	36	x	Surface of crack damp
G3		78	18	x	Water droplets formed on surface of crack
		79*	10**	x	Surface of chamfer wet
		80*	24**	x	Surface of chamfer wet
		81*	240**	x	Surface of chamfer wet
		82	3	x	Surface of crack damp
		83	3	x	Surface of crack damp
		84	3	x	Surface of crack damp
H3	North/West/ South	85*	312**	x	Surface of crack damp
	South	86*	12**	x	Surface of crack damp
H5	West	86	4	x	Water droplets formed on surface of crack
	West	87	16	x	Water droplets formed on surface of crack
	West	88	4	x	Water droplets formed on surface of crack
	West	89	12	x	Water droplets formed on surface of crack
	South	90	6	x	Water droplets formed on surface of crack
	East	91	12	x	Water droplets formed on surface of crack

* Leakage noted around column perimeter
** Length of leakage path around column perimeter
x Unrepaired crack
(†) Repaired crack
(††) Construction joint

Table 1A (Cont'd)
Locations of Water Leakage on the Underside of the Floor Slab
After the Douse Test

Location of Leak		Crack Number See Figure 1 of the text	Length (In)	Crack Repair Status	Remarks Types of leakage noted at cracks
Column Number	Bearing				
H6	East	92	10	x	Water droplets formed on surface of crack
	East	93	10	x	Water droplets formed on surface of crack
H7	East	94	24	x	Water droplets formed on surface of crack
	South	95	10	x	Water droplets formed on surface of crack
	South	96	20	x	Water droplets formed on surface of crack
H7-J7		97	40	x	Water droplets formed on surface of crack
H8	North	98	8	x	Water droplets formed on surface of crack
H11	North	99	3	x	Surface of crack damp
H11	West	100*	36**	x	Surface of chamfer damp
J7	North	101	10	x	Surface of crack damp
	North	102	12	x	Surface of crack damp
	North	103	3	x	Surface of crack damp
	North	104	16	x	Water droplets formed on surface of crack
	East	105	14	x	Water droplets formed on surface of crack
	East	106	16	x	Water droplets formed on surface of crack
J5	West	107	16	x	Water droplets formed on surface of crack
L8	East	108	12	x	Surface of crack damp

* Leakage noted around column perimeter
** Length of leakage path around column perimeter
x Unrepaired crack
(†) Repaired crack
(††) Construction joint